Economic value and production characteristics of table honey

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Abstract

Most honey produced globally is classed as table honey, for direct consumption, as distinct from higher value medicinal grade honeys. Economic value of honey was based on domestic table honey price in AU$ derived from Australia (AU) and United States (US), from 2010-2021 and sourced from AU honey processors and the US Department of Agriculture. For 2021, average AU and US domestic honey values were AU$5.70 and AU$6.53 per kg respectively. Domestic price slopes for 2010-2021 were similar for AU and US at an increase of AU$0.28 per year. Characteristics for honey production (HP) per hive per year were collated from four manuscripts and three AU datasets, presenting a substantial range of means (8.5 to 123.3kg), and standard deviations (2.6 to 42.8kg). Variability in HP between studies is attributed to differences in phenotyping, genotype, environment and production scale.

Introduction

Honey accounts for 85% of Australian (AU) beekeeper income (ABARES, 2016). Surveyed AU beekeepers nominated honey production (HP) as the top trait for selection (Chapman and Frost, 2020). Due to lack of selection for the trait, a need to improve overall beekeeper management, and variable access to nectar-yielding plant species, HP is not fully realised. In regard to genetic improvement, Petersen's (2020) review of honey bee breeding program design notes selective breeding in honey bees is primarily undertaken by researchers for a single trait or in small-scale production systems, with little uptake from or benefit to beekeepers operating large-scale production systems. Such large-scale systems are common in AU. The National Honey Bee Genetic Improvement Program (Plan Bee) will develop a breeding program to improve productivity of the large-scale AU beekeeping industry. As a first step towards this aim, deriving the economic value of table honey and evaluating HP phenotype data on individual hives with fixed queens over twelve months is necessary because the beekeeping industry lacks formalised breeding objectives for large-scale production systems. Literature was reviewed for the economic value of table honey. A lack of economic value, besides subjective weighting of traits by percentage value out of 100, (Van Engelsdorp and Otis, 2000, Zakour and Bienefeld, 2014) necessitated the present study to derive it. This study derives the economic value of honey in two beekeeping industries with comparable production systems (AU and United States (US)) and summarises HP characteristics.

Materials & Methods

The economic value for honey was derived and prices over time for two comparable markets (AU and US domestic and AU export) were documented. Cost of production was examined in the AU context. Published and unpublished AU data for HP per hive in large-scale systems across one full and two partial twelve month seasons were compared with other studies including HP characteristics.

Results

Production characteristics varied considerably between studies (Table 1). Variability reflects differences in phenotyping, genotype, environment and production system. Phenotyping methods included estimation of HP by number of honey combs times a factor of 2.5 (Zakour *et al.,* 2012), measuring weight difference of combs before and after extraction of honey plus an estimate of honey remaining in the broodnest (Bienefeld and Pirchner, 1990), and weight difference of combs before and after honey extraction by itself (Banks *et al.*, 2020, *Brascamp et al.,* 2018, Plan Bee, 2021). Subspecies of honey bees analysed included *Apis mellifera syriaca* (Zakour *et al.,* 2012), *Apis mellifera carnica* (Bienefeld and Pirchner, 1990, Brascamp *et al.,* 2018) and *Apis mellifera* hybrids (Banks *et al.*, 2020, Plan Bee, 2021). Production systems can reflect hives fixed in one location or migrated between locations, small (< 200 hives) or large scale (> 200 hives), and mixed (both small and large scale included). A mean of 30kg for HP across 18 Austrian production years (Brascamp, 2016) compared to means of 41.5 and 44.19 for partial and 123.27 for full AU production years (*Banks et al., 2020* and Plan Bee, 2021 datasets) illustrates the difference between European and AU production systems and environments. Datasets from AU (Banks *et al.*, 2020, Plan Bee, 2021) were generated from large scale, migratory production systems. Other datasets (Bienefeld and Pirchner, 1990, Brascamp *et al.,* 2018, Zakour *et al.,* 2012) included both stationary and migratory small (< 200 hives per beekeeper) and large-scale production systems (> 200 hives per beekeeper).

Table 1. Overview of honey production characteristics for hives with a fixed queen over single or multiple honey harvesting events in one or more twelve month periods.

Study	Mean	*S*	Min/Max	PS
Banks et al. (2020) AU Pop 1 2018-19	41.5	18.2	0.0/136.0	Large
Banks et al. (2020) AU Pop 2 2019-20	123.3	42.8	25.6/195.9	Large
Bienefeld and Pirchner (1990) Germany	24.1	13.9	0.0/99.8	Mixed
Brascamp et al. (2018) Austria	30.0	15.8	0.1/202.0	Mixed
Zakour et al. (2012) Syria Pop 1	8.5	3.3	0.5/23.8	Mixed
Zakour et al. (2012) Syria Pop 2	10.2	2.6	1.0/20.0	Mixed
Plan Bee AU 2021	44.2	14.8	0.0/96.6	Large

S standard deviation, *Min* minimum, *Max* maximum, *PS* production system, *Pop* population.

Economic value. The economic value of honey was derived from the price in AU$ of one kilogram of honey. Average honey prices from AU and US domestic markets and AU export markets from 2010 to 2021 were sourced from the AU beekeeping industry and US Department of Agriculture. Average annual exchange rates from 2010 to 2020 (www.exchangerates.org.uk) were used to convert US$/lb to AU$/kg for US domestic and US$/kg to AU$/kg for AU export prices. Linear regression was used to quantify the change in honey price for different markets over time. The export market price for table honey was higher than domestic market prices in

recent years. The high export price in 2020 is a result of depressed domestic supply and increased demand from overseas markets. The economic value of honey was AU$5.70/kg for the 2021 AU domestic market, with 2022 economic value of AU$6.42/kg expected. Linear regression of table honey price for AU and US domestic shows a steady increase in domestic price (Figure 1). Honey price (AU and US domestic) over time generated a positive, parallel slope of 0.28. Export price (AU) yielded a slope of 1.32. Price for table honey increased consistently over time with minimal variation from the overall slope which explained 81 to 85% (coefficients of determination) of the variation in price of honey over time.

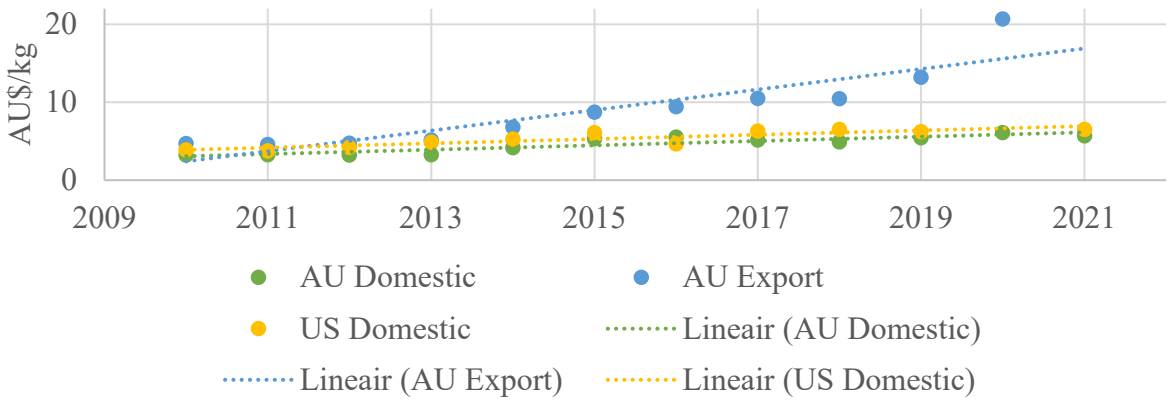

Figure 1. Honey (AU$/kg) price over time in different markets.

Expected costs to large scale AU producers for each added kg honey per hive are hardware, labour and freight. Large variability in HP across AU hives (Table 1), indicates that an increase of 1kg per hive can be captured within existing hardware (i.e. honey boxes, cooperative-owned bulk containers) and available labour, negating any increase in equipment or labour at this stage (Banks *et al.*, 2020, N.G. Bingley, C.C. Cooper, C.F. Horner, personal communications). Given our mean, freight is the only added cost to produce additional honey (AU$0.04/kg) at the current time so the economic value of HP is given as price per kilogram AU$5.70 on the domestic market.

Discussion

Price differences illustrate variation in economic value for table honey over time and between markets which need to be considered in bee breeding programs. Although economic value was not found in the literature, the price weighting of honey as a subjective percentage (34.4% ± 2.40 and 55.3% respectively), in addition to other traits totalling 100%, shows a range of trait emphasis in breeding objectives specific to production system, genotype and environment between Canada and Syria (Van Engelsdorp and Otis, 2000, Zakour and Bienefeld, 2014). This highlights the need for AU economic models to derive relative economic values for top AU traits. Secure growth in the AU domestic market supports increased selection for HP. Where export market targeting is possible at the producer level, an extra value upward of AU$15/kg,

excluding marketing costs, is expected. Datasets from AU are testament to environmental conditions for HP which surpass those in other study environments. Additionally, the AU datasets result from large-scale production systems which migrate hives to multiple honey making events in a twelve-month period. Comparatively, other datasets include a mix of small and large-scale production systems and both migratory and stationary honey producers. The substantial range in HP characteristics between the literature and AU datasets highlights the need to establish the differences between datasets in other countries and AU genotypes, environment and production systems to ensure accurate analysis. AU datasets presented are indicative of large-scale production systems where colonies are transported to subsequent honey production environments unique in aspects of climate, plant species, nectar production and duration to those northern hemisphere environments within the literature. Phenotyping is currently underway in AU through Plan Bee. Phenotypic data for AU-preferred traits and pedigree information will enable selection tailored to the AU environment, thereby improving the viability of the AU beekeeping industry and contributing to a global model applicable to large-scale production systems.

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